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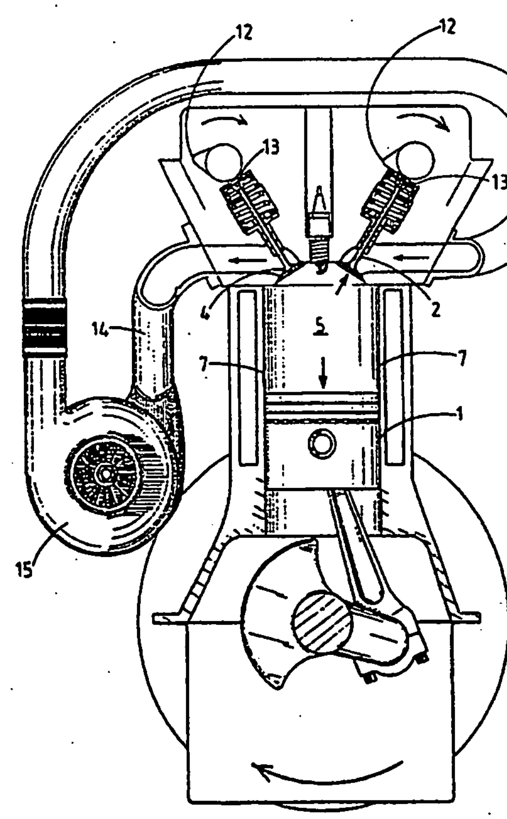
With amended claims.

(54) Title: A RESTRICTED INDUCTION RECIPROCATING PISTON TYPE INTERNAL COMBUSTION ENGINE

(57) Abstract

A four stroke reciprocating piston type internal combustion engine in which an expansion ratio in each cylinder is greater than the compression ratio of the cylinder. This may be created by closing an intake valve or valves (2) of each cylinder while a piston (1) of said cylinder has travelled only part of its induction stroke, or by providing a variable restriction in the inlet system varying inversely with engine speed. In the case where closure of the intake valve or valves (2) is effected before the induction stroke is completed, the point of closure during the engine cycle is shifted from before completion of the induction stroke at lower engine speeds to after completion of the induction stroke at higher engine speeds.



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A RESTRICTED INDUCTION RECIPROCATING PISTON TYPE INTERNAL COMBUSTION ENGINE

This invention relates to a four stroke reciprocating piston type internal combustion engine which provides for differential displacement by providing for an expansion volume that is greater than its compression volume.

An object of the invention is to provide in a reciprocating piston type internal combustion engine an expansion ratio that is greater than its compression ratio so that it is more efficient in operation.

According to a broadest aspect of the invention there is provided a reciprocating piston type internal combustion engine in which an expansion ratio in each cylinder is greater than the compression ratio of the cylinder.

According to one aspect of the invention a reciprocating piston type internal combustion engine is adapted to operate so as to close an intake valve or valves of each cylinder while a piston of said cylinder has travelled only part of its induction stroke.

This closing of the intake valve(s) reduces the density of the intake charge in the cylinder to below that of atmospheric air pressure outside the cylinder as each piston travels through the full length of its stroke. This also reduces the density of the intake charge in the cylinder to below that of the intake charge immediately outside the cylinder when the inlet valve(s) closes.

After each piston has travelled part way on what would normally be the start of a compression stroke for a conventional four cycle engine, that is the first return movement of the piston after it has travelled its full stroke length to effect intake charge induction and while the piston has only moved through a fraction of its return movement or stroke following the end of its induction stroke and which returning to a similar position to that for which the inlet valve or valves closed during induction, the intake charge inside the cylinder would resume or be closer to the density of the atmospheric air outside the cylinder and the piston would begin its effective compression stroke to take pressures above atmospheric pressure. It is important that compression pressures are as high as possible before ignition. This provides for a compressed volume with a greater pressure differential from the expanded volume for each cylinder thereby providing for greater efficiency of operation.

The invention also provides in accordance with a third aspect a means for purging exhaust gases from a cylinder of an internal combustion engine by adjusting valve timing of the engine to increase the overlap where both inlet and exhaust valve(s) are open.

The overlap can be created by manufacturing a cam shaft which substantially opens an inlet valve or valves up to 50° before piston top dead centre and holds open exhaust valves or valves until up to 50° after top dead centre.

The valve(s) particularly the inlet valve(s) can be electronically controlled and actuated by solenoids or other electromagnetic devices thus easily taking advantage of variable valve timing for the benefit of this invention.

As engine speed reduces during operation a variable restriction can be used to reduce the volume of air entering each cylinder thereby reducing the chance of detonation. This variable restriction can be in the air inlet system and would be independent of any other throttling device, It would be open for high speed operation.

The expression "intake charge" means different things depending on whether the engine is a petrol/gas engine where the intake charge is a fuel/air mixture or a diesel engine where the intake charge is air only.

According to another aspect of the invention a reciprocating piston type internal combustion engine has an expansion ratio in each cylinder greater than the compression ratio caused by providing a restriction in an air inlet system of the engine.

The electronic ignition or fuel injection timing can be delayed for low speed operation so as to prevent detonation but could be advanced for high speed operation. The amount of fuel entering each cylinder can be reduced for low speed operation so as to prevent detonation and increased for high speed operation. A governing device can control this operation.

The engine can be constructed as is known in the art but the intake valve or valves of each cylinder is (are) arranged to have an abbreviated action that only occurs during part of the induction stroke. The intake valve or valves' action during induction is smaller in duration and opening than the action of regular intake valve movement of four cycle engines. The valves of this engine can be retained by valve springs or other mechanisms of sufficient strength to keep the valve(s) seated during the piston movement that takes cylinder pressures below atmospheric pressure.

Further aspects of the invention which should be considered in all its novel aspects will become apparent from the following descriptions which are given by way of example only.

Examples of the invention will become apparent from the following descriptions with reference to the accompanying drawings in which:

Figure 1 shows diagrammatically and in sequence movement of a piston and valves of an engine incorporating the present invention;

Figures 2(a) & (b) shows diagrammatically an engine incorporating a blower or turbo effect;

Figure 3 shows diagrammatically a cylinder head and bore fitted with a fuel injector;

Figure 4 shows another construction where intake air is restricted to reduce inducted air/fuel mixture to an engine;

Figure 5 shows a vertical section through a preferred example of engine incorporating the present invention;

Figure 6 shows a vertical section through a cylinder head for a direct injection diesel powered engine showing a preferred shape of piston crown;

Figure 7 shows diagrammatically valve timing opening and closing in accordance with the third aspect of the invention; and

Figure 8 shows diagrammatically an engine incorporating in series a turbocharger and supercharger which offers improved engine performance.

In the following examples similar parts are indicated where possible by similar numerals.

Figure 1 shows the cycle of events where in the drawing marked A the piston 1 is moving down on its intake stroke. In B the intake valve 2 is closed and the piston 1 is still moving down. In C the piston 1 is in a similar position to B but is moving up on its compression stroke. It is at the point where the cylinder pressures are close to the atmospheric air outside the cylinder. The fuel is either injected arrow 3 in D or slightly before. Alternatively the fuel could be carried in with the intake air from a carburettor or injection system that is external to the cylinder. In D the fuel is ignited either by pressure or spark ignition. In E the piston is travelling down on its power stroke. In F the exhaust stroke has begun and the exhaust valve 4 is open.

The effective compression volume is shown G and the effective expansion volume is shown H. Although H is about thirty-three percent greater than G in Figure 1, the difference could be greater or smaller than indicated.

As an alternative arrangement the inlet valve(s) of this engine could be operated independently from a camshaft (not shown) as it would be possible for the induction depression in the cylinder to provide sufficient opening of the inlet valve 2 if the retaining spring attached to the inlet valve or valves was of sufficiently light strength though still strong enough to restrict the induction into the cylinder.

As a further alternative an air compressor or turbo charger could be used to keep the intake charge density up to the desired level as the engine speed rises. The compressor or blower would either be powered by exhaust gas energy or it would be mechanically driven by the engine. It would also possibly be arranged to operate when the induction volume fell below the desired level for this engine.

Figure 2 shows a blower or turbocharger arrangement. Optional intake charge coolers are shown at X and X while the flow arrows indicate air flow.

An example of combustion chamber 5 design is shown in Figure 3 and is applicable to a direct injection engine. Insulation is shown at Y and Y and a fire ring is shown at Z and Z.

With this combustion chamber 5 the fuel can hit the slopes 6 radiating out on top of the piston 1 and can be

deflected up to the fire ring Z where a ridged surface (not shown) on the fire ring 2 will arrest the fuel. The recessing of the fire ring Z to a diameter that is greater than the cylinder bore means that fuel can be deflected back into the combustion chamber 5 rather than being left to run down the cylinder walls 7. The purpose of the insulation material Y, which could be a thick gasket, is to retain heat in cylinder head 8 so as to promote good combustion and fast warm up. The engine could be liquid or air cooled. In Figure 3 the fuel injector is shown at 9 and fuel flow arrows are shown at the bottom 10 of injector 9.

An advantage of this invention is that it has high thermal efficiency so that the maximum amount of fuel can be converted to work and environmental pollution will be low. It is to be appreciated that this invention can be interpreted in many ways and is not limited to the comments and illustration shown here.

Figure 4 shows another version where the intake air or fuel-air mixture has a variable restriction at 11 to keep the intake pressure low in accordance with this invention to engine 12 which is shown diagrammatically. This restriction allows more flow as engine speed rises and would reduce flow at lower engine speeds. The engine compression ratio would be high so as to compensate for the restriction and to provide the engine with good pressure differential. In Figure 4 the restriction at 11 could be between a carburettor and the inlet valve(s) or between a fuel injection system and

inlet valve(s) or in front of these items. It could also be in an air inlet system for a diesel engine.

Another option for this invention is to allow for variable valve timing such as delaying the closure of the inlet valve or valves to compensate for reduced volumetric efficiency as engine speeds rise and/or to aid starting at low cranking speeds. This could be achieved by retarding the inlet valve cam lobes as engine speeds rise and/or also at low cranking speeds.

In Figure 7 is shown diagrammatically the positions, relative to top dead centre (TDC) and bottom dead centre (BDC) of crankshaft rotation, at which inlet and exhaust valve(s) are opened and closed. By increasing the degree of overlap at which both the inlet and exhaust valves are open a better flow of inlet or exhaust charge can be obtained. This has been verified by the applicant in trials to both improve efficiency and reduce exhaust emissions in a diesel type engine.

The points identified as "maximum lift" are the points at which lobes on the cam shaft hold the respective valve(s) fully open. This diagram can be used as a basis for the construction of a cam shaft. The provision of greater overlap ensures a better purging effect during the exhaust cycle, when used with a free flowing exhaust system.

Therefore according to this invention an engine would operate on the smallest practical amount of air and combine it with the smallest practical amount of fuel. The engine compresses the mixture to the highest practical level before

ignition and it expands to the lowest practical level before exhausting the burnt gasses from the engine.

In Figure 5 the piston 1 is shown travelling down its intake stroke and has completed 60%-70% of its travel. It is at a point where the inlet valve 2 has just closed as a cam lobe 12 has immediately rotated off a cam follower 13. This means the inlet valve 2 closes before the piston 1 reaches the end of its induction stroke. The cam timing is designed to facilitate this. The exhaust valve 4 to exhaust system 14 at this point has no action and remains closed. As the piston 1 travels on down to complete the full length of its stroke, it will increase the volume of the intake charge but no more mass will be added to the intake charge as the valves 2, 4 remain firmly shut.

This means the density of the intake charge in the cylinder 5, will be reduced to below that of the charge air sitting between a turbo-charger 15 and the inlet valve 2. This will aid vaporisation of the fuel air mixture if it is carried in with the intake air as a reduction in density reduces the vapour point temperature. It also means that the engine will have an expansion ratio that exceeds the compression ratio as the actual compression ratio (defined from the point at which the inlet valve 2 closes during induction) is only 60%-70% of the nominal compression ratio while the actual expansion ratio for the combustion gasses will be the reverse of the nominal compression ratio; this arrangement improves thermal efficiency.

The turbo-charger 15 as indicated is optionally fitted to aid cylinder 5 filling at higher engine speeds, a supercharger (not shown) could be used for the same practice. At low engine speeds when the turbo-charger 15 has no or little effect the density of the intake charge in the cylinder 5 will be reduced to below that of the atmospheric air outside the engine. This further advances thermal efficiency.

In Figure 6 is shown a piston 1 with a shallow depression 16 in the piston crown. For a direct injection diesel engine experiments have shown improved purging of exhaust gases. Not shown in this drawing are valve pockets in the crown of the piston 1. The valve pockets are necessary to ensure that in use the reciprocating piston 1 is clear of the partly open valves which open and close later than normal and might interfere with piston.

In Figure 8 is shown a restricted induction engine with a turbocharger used in a series with a supercharger. The turbocharger/supercharger supply the intake charge to the engine.

The turbocharger 15 is driven by the exhaust gases with its compressor wheel 17 forcing air to the inlet of the supercharger 16. The supercharger 16 can be mechanically driven by the engine 12 via belt 19. The supercharger 16 supplies pressurised intake charge to the cylinders.

The advantage of the invention is that at low engine speed with extended valve overlap as proposed in Figure 7,

the supercharger 16 more effectively resists the back blow of exhaust gases. As engine speed rises the turbocharger pressurizers the intake of the supercharger thereby reducing the drive load of the supercharger.

Particular examples of the invention have been described and it is envisaged that improvements and modifications can take place without departing from the scope thereof.

CLAIMS:

1. A reciprocating piston type internal combustion engine in which an expansion ratio of the engine is designed to exceed its compression ratio by deliberately restricting the amount of intake charge entering each cylinder.

2. A reciprocating piston type internal combustion engine in which the full load intake air or charge entering each cylinder is of less density than the swept volume of the cylinder would allow and is deliberately restricted and where said engine is designed to take advantage of the restricted intake air or charge by having a nominal compression ratio which is numerically high for the purpose of optimising thermal efficiency.

3. A reciprocating piston type internal combustion engine as claimed in claim 2 in which the intake air or charge is deliberately restricted for the purpose of optimising fuel efficiency.

4. A reciprocating piston type internal combustion engine as claimed in claims 2 and 3 in which the fuel entering each cylinder is restricted to match the restricted air entering each cylinder.

5. A reciprocating piston type internal combustion engine as claimed in claims 2 and 3 in which a means of restricting the air or charge entering each cylinder is to close each intake valve before a related piston reaches the extreme of its travel that equals the sweep for maximum cylinder volume at the end of the induction stroke.

6. A reciprocating piston type internal combustion engine as claimed in claims 2 and 3 in which a means of restricting the air or charge entering each cylinder is to use at least one variable restriction in the inlet system ahead of each inlet valve or inlet port and each variable restriction would be arranged so as to increase restriction to air or charge flow into each cylinder at low engine speed and to reduce restriction to air or charge flow into each cylinder at high engine speed.

7. A reciprocating piston type internal combustion engine as claimed in claims 2, 3 and 5 in which the timing of the operation of some or all of the valves is variable and in particular with reference to the inlet valves where each inlet valve could be arranged to close earlier at low engine speeds and to close later at high engine speeds and/or very low cranking speeds.

8. A reciprocating piston type internal combustion engine as claimed in claims 2, 3 and 5 in which the timing of the

operation of all or some of the valves is variable and in particular with reference to the inlet valves where each inlet valve would be arranged to close before the end of the piston travel during the induction stroke during low engine speed operation and then vary toward closing after the piston starts its return movement following the induction stroke during high engine speed operation.

9. A reciprocating piston type internal combustion engine as claimed in any one of the aforegoing claims wherein the numerical compression ratio is higher than that engine would require to use and in fact would be higher than the engine could safely handle if allowed to fully aspirate and where this numerically high compression ratio is used to compensate for the deliberate partial filling of each cylinder.

10. A reciprocating piston type internal combustion engine as claimed in any one of the above claims wherein a turbocharger or super charger is used to aid cylinder charging at high engine speeds.

11. A reciprocating piston type internal combustion engine as claimed in any one of the aforegoing claims wherein the principal design objective are to use the smallest practical amount of air and compress it to the highest practical pressure before ignition with the smallest practical amount of fuel and to expand the products of combustion down to the

lowest practical pressure before exhausting the charge from each cylinder.

12. A reciprocating piston type internal combustion engine as claimed in any one of the above claims wherein the intake air or charge is deliberately restricted so as to prevent detonation during combustion, due to a high compression ratio.

13. A reciprocating piston type internal combustion engine as claimed in any one of the above claims wherein the intake charge or air is deliberately restricted to prevent pre-ignition due to a very high compression ratio.

14. A reciprocating piston type internal combustion engine as claimed in any one of the above claims wherein the intake charge or air is deliberately restricted to prevent the compression temperature from reaching an excessively high temperature prior to ignition, due to a high compression ratio.

15. A reciprocating piston type internal combustion engine as claimed in any one of the above claims wherein either all or some of the valves are controlled by electronic devices so as to activate them and vary their operation timing.

16. A reciprocating piston type internal combustion engine as claimed in claim 15 in which the electronic device is a solenoid fitted to assist valve closure.

17. A reciprocating piston type internal combustion engine as claimed in claim 15 in which the electronic device is a solenoid fitted to assist valve opening.

18. A reciprocating piston type internal combustion engine as claimed in claim 15 in which the electronic device is a solenoid fitted to assist valve opening and closing.

19. A reciprocating piston type internal combustion engine with any combination of the aforegoing claims.

AMENDED CLAIMS

[received by the International Bureau on 07 March 1995 (07.03.95); original claims 1-19 replaced by amended claims 1-22 (6 pages)]

1. A four stroke reciprocating piston type internal combustion engine in which the timing of the operation of all or some of the valves and in particular the inlet valves is variable and where at least one inlet valve per cylinder is arranged, during low speed operation, to close before the end of piston travel in the cylinder during an induction stroke and, as engine speed increases, to vary towards closing after the piston starts its return movement following the induction stroke.

2. A reciprocating piston type internal combustion engine as claimed in claim 1, in which the expansion ratio in each cylinder, is designed to exceed its compression ratio by the practice of deliberately restricting the amount of intake charge to each cylinder.

3. A reciprocating piston type combustion engine as in claim 1 in which the full load intake air or charge entering each cylinder is less in density than the swept volume of the cylinder would allow and is deliberately restricted and were said engine is designed to take advantage of the restricted intake air or charge by having a nominal compression ratio which is numerically high for the purpose of optimising thermal efficiency.

4. A reciprocating piston type internal combustion engine as claimed in claim 3 in which the intake air or charge is deliberately restricted for the purpose of optimising fuel efficiency.

5. A reciprocating piston type internal combustion engine as claimed in claim 3 or claim 4 in which the fuel entering each cylinder is restricted to match the restricted air entering each cylinder.

6. A reciprocating piston type internal combustion engine as claimed in claims 3 or 4 in which a means of restricting the air or charge entering each cylinder is to close each inlet valve before a related piston reaches the extreme of its travel that equals the sweep for maximum cylinder volume at the end of the induction stroke.

7. A reciprocating piston type internal combustion engine in which a means of restricting the air or charge entering each cylinder is to use at least one variable restriction in an inlet system ahead of each inlet valve or inlet port and each variable restriction is arranged so as to increase restriction to air or fuel charge flow into each cylinder at low engine speed and vary to reduce restriction to air or fuel charge flow into each cylinder at high engine speed.

8. A reciprocating piston type internal combustion engine as claimed in claim 1 in which the timing of the operation of some or all of the valves is variable and in particular with reference to the inlet valves where all or some of the inlet valves are arranged to close earlier at low engine speeds and to close later at high engine speeds.

9. A reciprocating piston type internal combustion engine as claimed in any one of the aforegoing claims wherein the numerical compression ratio is higher than that engine would require to use and in fact would be higher than the engine could safely handle if allowed to fully aspirate and where this numerically high compression ratio is used to compensate for the deliberate partial filling of each cylinder.

10. A reciprocating piston type internal combustion engine as claimed in claims 1 and 7 wherein the numerical compression ratio is higher than the engine would be required to use and is higher than the engine could safely handle if allowed to fully aspirate and where this numerically high compression ratio is used to compensate for the deliberate partial filing of each cylinder.

11. An internal combustion engine as claimed in any one of the claims 1 to 10 wherein a turbo-charger or super-charger is used to aid cylinder charging.

12. An internal combustion engine as claimed in any one of claims 1 to 11 wherein the smallest practical amount of air is used and compressed to the highest practical pressure before ignition with the smallest practical amount of fuel and to expand the product of combustion down to the lowest practical pressure before exhausting the exhaust charge from each cylinder.

13. An internal combustion engine as claimed in any one of claims 1 to 11 wherein the intake air or charge is deliberately restricted so as to prevent detonation during combustion, due to a high compression ratio.

14. An internal combustion engine as claimed in any one of claims 1 to 11 wherein the intake charge or air is deliberately restricted to prevent pre-ignition due to a very high compression ratio.

15. An internal combustion engine as claimed in any one of claims 1 to 11 wherein the intake charge or air is deliberately restricted to prevent the compression temperature from reaching an excessively high temperature prior to ignition, due to a high compression ratio.

16. A reciprocating piston type internal combustion engine as claimed in claim 1 wherein either all or some of the

valves are controlled by electronic devices so as to activate then and vary their operational timing.

17. A reciprocating piston type internal combustion engine as claimed in claim 1 in which the electronic device is a solenoid fitted to assist valve closure.

18. A reciprocating piston type internal combustion engine as claimed in claim 1 in which the electronic device is a solenoid fitted to assist valve opening.

19. A reciprocating piston type internal combustion engine as claimed in claim 1 in which the electronic device is a solenoid fitted to assist opening and closing.

20. A four stroke reciprocating piston type internal combustion engine using a turbo-charger and super-charger in combination and in which engine the inlet valves are closed before the end of the induction stroke.

21. A reciprocating piston type internal combustion engine as claimed in claim 20 in which all or some of the inlet valves have variable timing according to claim 1.

22. A reciprocating piston type internal combustion engine as claimed in claims 1, 16, 20 or 21 in which all or some of the inlet valves are held open until after the end of the

induction stroke at slow starting speed, and said valves are closed while a piston is returning on the early stages of a compression stroke, this action being to facilitate cylinder filling with intake charge at slow starting or cranking speeds, after which the valve action returns to that defined in claims 1. 16, 20 or 21.

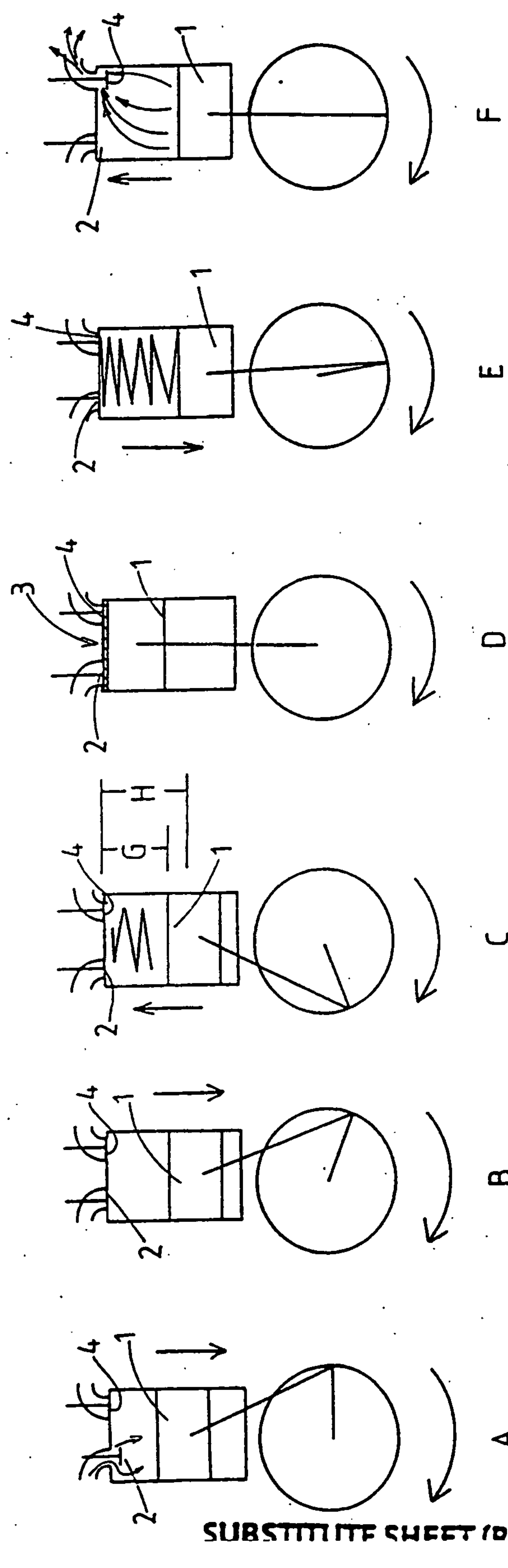

FIGURE 1

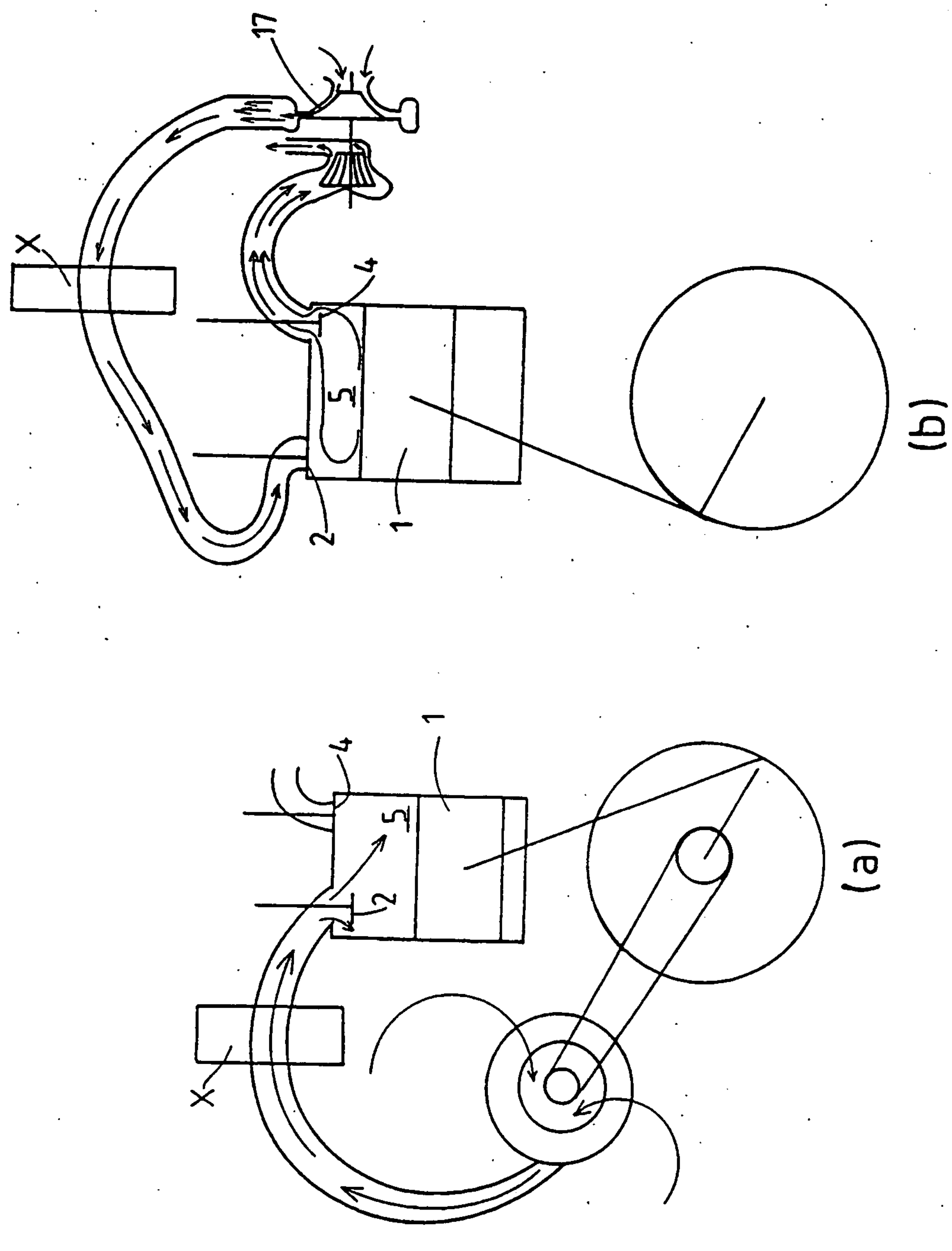

FIGURE 2

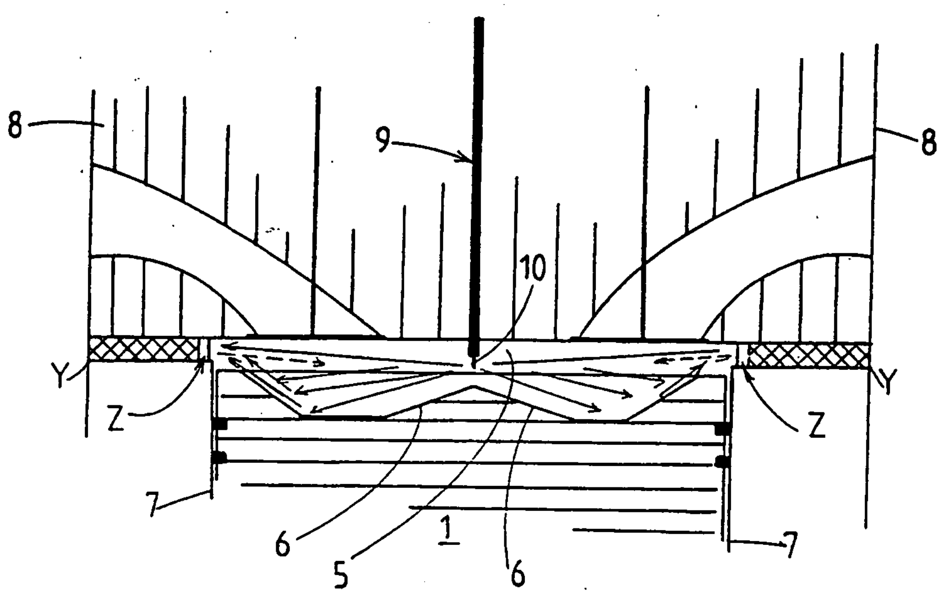

FIGURE 3

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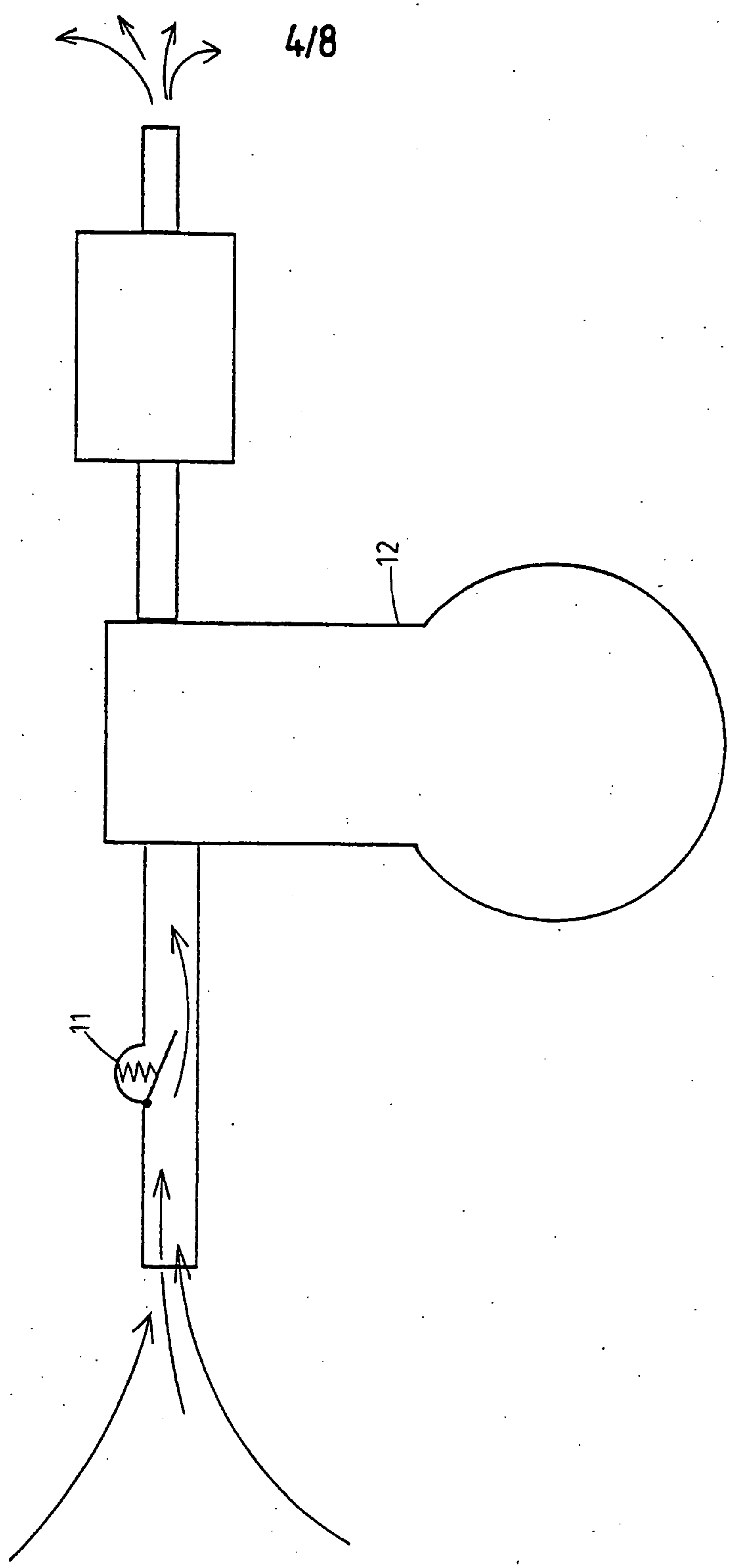

FIGURE 4

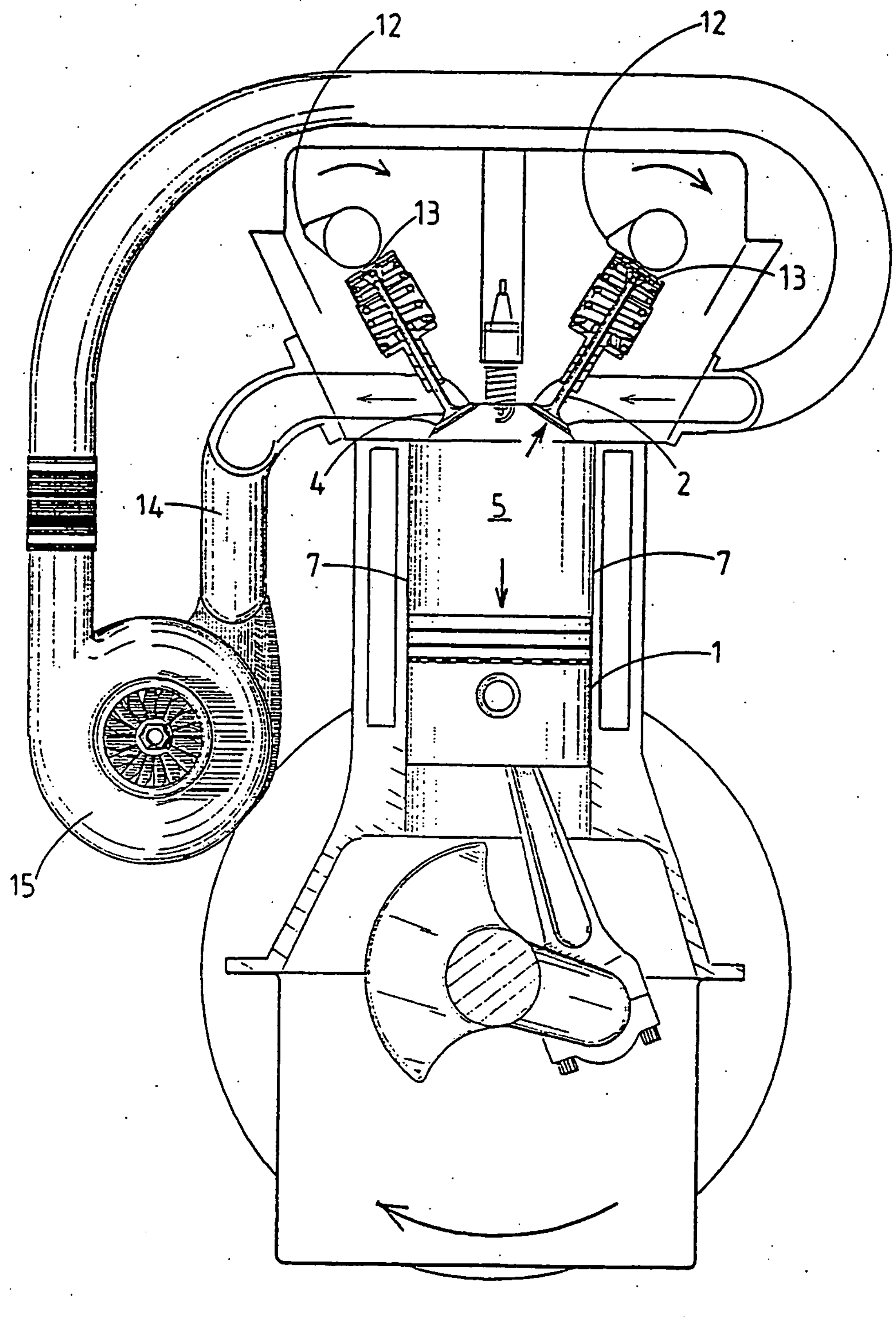

FIGURE 5

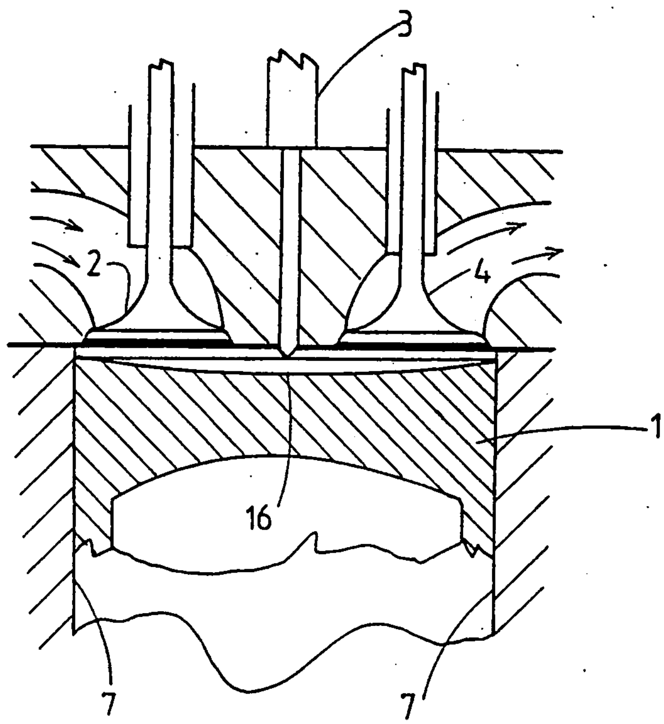

FIGURE 6

VALVE TIMING

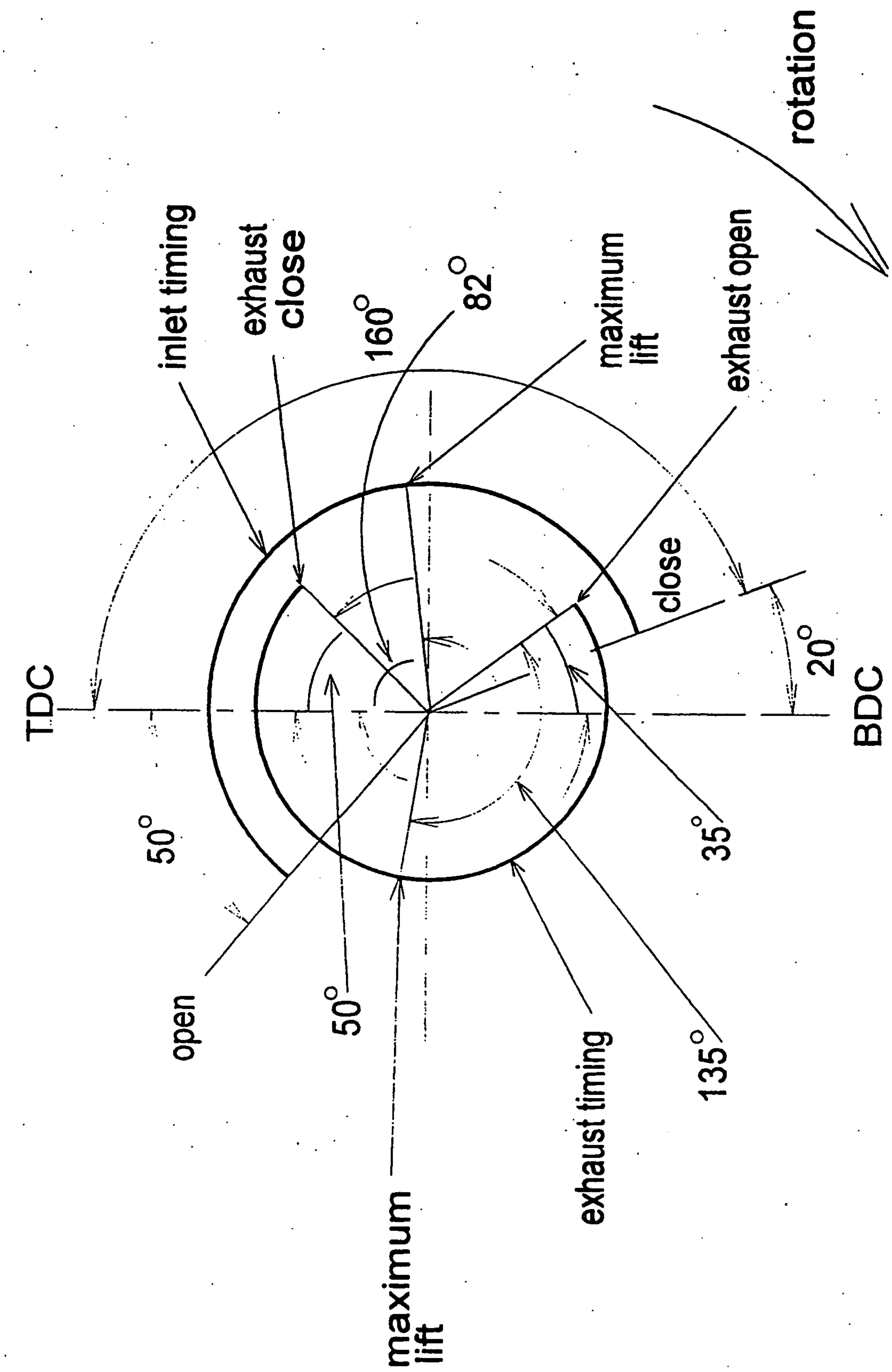

FIGURE 7

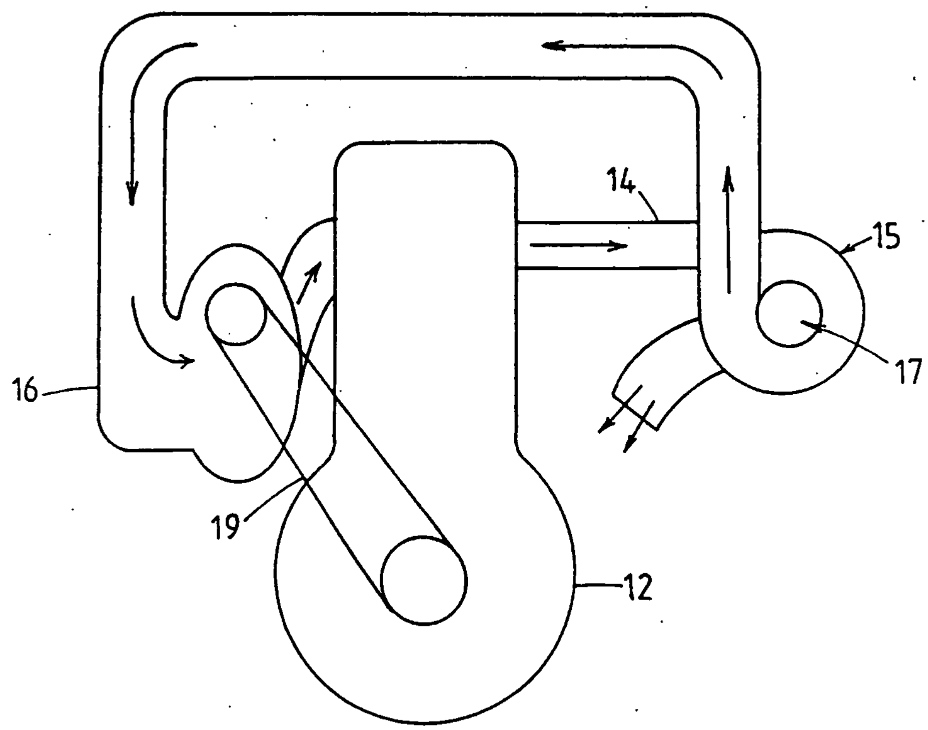

FIGURE 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ 94/00109

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.^{6} F02B 41/02, F02D 15/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : F02B 41/02, 29/08, F02D 15/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)
DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	WO,A, 89/00643 (BEVERLEY) 26 January 1989 (26.01.89) page 4, lines 20-29	1-6, 9-14
X	Patent Abstracts of Japan, M-732, page 77, JP,A, 52-11331 (KAMEI) 28 January 1977 (28.01.77) whole abstract	1-4, 6, 9-14
X	US,A, 2773490 (MILLER) 11 December 1956 (11.12.56) figure 3	1-5, 7, 9-14
Y	column 3, lines 56-59	15-18

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
4 January 1995 (04.01.95)	11 Jan 1995 (11.1.95)

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. 06 2853929	C.M. WYATT Telephone No. (06) 2832538

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
Y	WO,A, 92/02712 (RICHARDS et al) 20 February 1992 (20.02.92) page 2, lines 12-24	15-18
X	US,A, 2670595 (MILLER) 2 March 1954 (02.03.54) column 3, lines 36-67	1-5, 9-14

Box I **Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)**

This international search report has not established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claim No.: 19
because it is a dependent claim and is not drafted in accordance with the first and second sentences of Rule 6.4(a).

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ **The additional search fees were accompanied by the applicant's protest.**

☐ **No protest accompanied the payment of additional search fees.**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
WO	9202712	AU	82944/91

END OF ANNEX